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(54) Optical fiber link card module

Lichtwellenleiterverbindungskartemodul

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Description

The invention relates generally to methods and apparatus for converting electrical signals to and from optical signals. More particularly, the invention relates to an optical fiber link card which serves as part of a communication module (not necessarily an enclosed or encapsulated device) for converting between parallel electrical signals and serial optical signals, and to a process for fabricating the module.

Many types of electro-optical converters and connectors are described in issued patents and the technical literature. Commercially available devices are also presently available for performing these functions.

Examples of patents which describe electro-optical converters and connectors include US-A-4.545.077, to Drapala et al, which teaches an electrical multiplex data bus operatively connected to an optical multiplex data bus by means of an electro-optical converter; and US-A-4.597.631, to Flores et al, which teaches a passive electro-optical connector.

The Drapala et al invention is an example of a serial electrical to serial optical converter. Drapala et al operates as a tri-state repeater to effectively extend a three state data bus. The Flores invention is one of many connector devices that, although not dealing with electro-optical conversion per se, provides user access to transmitter/receiver assemblies via connectorized ports. The Flores device is an example of means for interconnecting both optical and electrical components in a hybrid system.

Commercially available connectorized electro-optical converters for performing serial optical to serial electrical (and vice versa) conversion, are available from Siemens and other companies. These devices, which are compatible with FDDI standards, IBM equipment, etc., are capable of achieving approximately 200 Mbits/sec. data rates.

Another example of a commercially available serial to serial converter is the AT&T ODL-200. This device is also capable of achieving approximately 200 Mbits/sec. data rates. The AT&T ODL-200 is described in an article entitled "Transmitter and Receiver Integrated Circuits for a 200 Mbits/sec. Optical Data Link", published in the proceedings of the IEEE 1986 Custom Integrated Circuits Conference.

The aforementioned commercially available devices utilize a single optical transmitter coupled through a fiber to a single receiver. Both the Siemens and AT&T devices allow full duplex communication with serial input/output. The receivers and transmitters used are hybrid ceramic substrates in dual inline packages. These packages are either hermetically sealed or plastic encapsulated.

Transceiver packages are also commercially available. For example, Mitsubishi Electric has made available transceiver packages having line bit rates of approximately 170 Mbits/sec., using a laser diode driver and optical receiver which are integrated onto a single side of a card. Similar to the aforementioned Siemens and AT&T transmitter/receiver modules, the Mitsubishi transceivers process input and output serially.

By placing the laser transmitter and receiver on the same side of a card, the Mitsubishi device requires means for electrically isolating these components. Typically metal shielding is used. Providing this isolation has heretofore limited the ability to manufacture a compact card onto which a plurality of transmitter and receiver pairs could be mounted.

Document Optical Fiber Communication Conference, Houston, February 1989, Vol. 5, Pages 83 and 84, describes opto/electronique link modules, wherein four receivers are integrated on a chip and four transmitters are integrated on a separate chip.

Document: Proceedings of the 36th Electronic Components Conference, Seattle, May 1986, Pages 280 and 281 describes an approach to fabricating a transmitter on one side of an four layer printed wiring board and a receiver on the other side, to achieve an optical fiber connector.

The demand for improved electro-optical converters and connectors is rapidly increasing as fiber optic technologies are adapted to provide solutions to performance and packaging problems associated with present day computer interconnect applications. More particularly, I/O pin limitations caused by use of wide parallel data busses, performance limitations on the length of electrical busses, and electromagnetic interference problems, suggest that serial optical communications be used to convey data at high speed between the parallel electrical busses to which computer components are often interconnected. The high data rates required to service wide parallel data busses, the packaging flexibility of connectorized optical transmitter/receiver assemblies, and the necessity for user access to these connectorized ports, has led to the design of small feature cards to interconnect computer elements.

One such card is included in the commercially available PCO-2001 Series Parallel Lightwave Interface Module. This module performs parallel electrical signal to serial optical conversion (and vice versa) and features serial signal rates of up to approximately 100 Mbits/sec. A longwave LED is used for an optical source. Specialized transmitter and receiver ICs are incorporated onto one side of a card and provide full duplex operation.

The PCO-2001 card allows next level applications packages to interface with a high speed serial fiber optic link without adding to the design complexity of the next level packaging or performance requirements. However, the PCO-2001 card is problematic because of the electrical signal power needed for a LED source to drive data in the 200 Mbits/sec. range (twice that of the published data rate for the PCO-2001 device); the size of the PCO-2001 card (attributable in part to providing the isolation required for the transmitter and receiver components mounted on the same side of the card); and the

inability to use a single, compact card to provide at least double full duplex operation.

Accordingly, it would be desirable if an optical fiber link card could be provided that supports a parallel user interface, such as a parallel data bus; performs parallel to serial conversion (and vice versa) for servicing a high speed serial optical link, where the optical transmitter on the card is capable of driving data in excess of 200 Mbits/sec. without requiring the electrical signal power needed for an LED source; and can support at least double full duplex connections in less space then is presently required to support single full duplex connections.

Furthermore, it would be desirable if the arrangement of the transmitter and receiver devices on such a card, together with the card itself, provided means to isolate transmitter and receiver electrical components without requiring excessive shielding or the amount of device separation required by the prior art.

Still further, it would be desirable if advantage could be taken of both sides of an optical data link card to increase the surface onto which components could be mounted to reduce card size. Further yet, it would be desirable to mount the optical components (and leads to these components) on the card in such a way as to facilitate easy access by a user and minimize lead capacitance and inductance to thereby further improve card performance.

To achieve the desired communication module many architecture, electrical and packaging problems need to be solved. For example, laser transmitters would be capable of achieving the desired data rates without requiring the electrical signal power required by LEDs; however, laser based systems must meet stringent safety requirements.

From a safety point of view, it would be desirable if a laser based optical fiber link card could be developed that is "fail safe", i.e., is certifiably safe at other than a total system level (where the system usually includes both hardware and software). The ability to produce a self-contained transmitter/receiver function in a certifiable package, completely independent of user system interface hardware and software, would ease restrictions on system level usage of a laser based card.

Many countries require certification of the "product" with respect to laser light emissions. Prior art laser based optical link subassemblies have a dependency on the "box" they are in to maintain compliance. If all the laser safety circuitry were on board the optical fiber link card, then the card would become the "product" that needs to be certified; not all the different models of boxes that it is used in. This would simplify the safety certification process for the user. More particularly, it would be desirable if an optical fiber link card could be devised that maintains known worldwide standards for class 1 operation under a single component failure.

In addition to all of the above, it would be desirable if an optical fiber link card communication module containing the features described hereinbefore also (1) provides a byte sync signal to the user, since many optical link subassemblies deliver fragmented parallel data; (2) provides a fault line to the user to aid in determining which end of an optical link suffers a failure; (3) provides an electrical wrap capability for diagnostic purposes; (4) requires only a single +5 volt supply which would make the card compatible with single voltage logic families; (5) maintains good thermal isolation between the electronics and the laser; (6) provides a package adaptable to multiple next level packaging; (7) uses standard surface mount assembly techniques instead of the expensive ceramic hybrid hermetic packaged subassem blies (particularly for the optical drivers and receivers) used by the prior art to achieve high data rates; and (8) is compact, i.e., small in size and height compared to known systems.

It is an object of the invention to provide a high speed optical fiber link card communication module that is capable of transmitting (or receiving) approximately 200 Mbits/sec. data serially over fiber optic media and which provides a parallel electrical interface to the user.

It is a further object of the invention to contain the high frequency signals coming off of (or going onto) the serial link, and serializer/deserializer functions, to the link card itself.

It is still a further object of the invention to provide an optical fiber link card communications module that can provide at least a double full duplex, where the card is compact and maintains a small form factor (for high density packaging) as compared with prior art devices, while maintaining a low height profile to the next level package to which it attaches.

Further still, it is an object of the invention to provide an optical fiber link card communication module that utilizes laser transmitters and provides self contained laser safety features so as to be certifiably safe, independent of user interface hardware or software.
In particular, it is an object of the invention to provide safe, class 1, laser operating conditions under single fault conditions, and to provide means which facilitate the detection of laser failures and provide an indication of such failures to the user to aid in fault diagnosis.

Other objects of the invention include providing a module that outputs a byte synchronization signal to the user and non-fragmented parallel data; and providing a module that maintains good thermal isolation between the electronics and optical devices (in particular lasers) utilized.

According to the invention, a double sided surface mount optical fiber link card is used as part of a communication module that provides a parallel electrical interface to the user and transmits/receives high speed serial data over an optical data link. The card includes means for interfacing with at least one n-bit wide parallel electrical data bus; means for interfacing with at least one high speed optical data link; and a plurality of converters for performing conversion between both electrical and optical signals. At least one of these converters includes

serializer means for serializing parallel data input for transmission, and modulating the serialized transmit data onto a semiconductor laser mounted on the card. At least one other converter includes an optical receiver (e. g., a PIN photodiode), amplifier and deserializer means, for respectively receiving, amplifying and recovering the clock to drive n-bit wide receive data onto a parallel bus.

According to one embodiment of the invention the optical components are edge mounted and have their leads mounted on the surface of the card (as opposed to standard pin-in-hole type leads) to minimize lead capacitance and inductance. Additionally, control means for the converters, and safety shut down means, are located on the same card as the electrical and optical components.

According to the invention, the optical communication module, includes a single multilayer double surface mount optical fiber link card having a plurality of converters mounted thereon, for converting between parallel electrical signals and serial optical signals, wherein said optical signals are transmitted and received by the module over that at least one full duplex optical communication link, comprises first optical assembly means, electrically coupled to at least one of said plurality of converters, including at least one axial leaded optical transmitter that is optically coupled to said communication link; and is being characterized in that it comprises retainer means, for holding said first optical assembly means in proximity to an edge of said card so as to align said at least one optical transmitter to said edge and facilitate attaching the leads of said at least one optical transmitter to the surface of said card.

A preferred embodiment of the invention contemplates including in the optical communication module a single multilayer card with all the transmitter electrical components being located on one side of the card, all receiver electrical components being located on the other side of the card, with the transmitter and receiver components being electrically isolated from each other and separated by shielding layers in the card. By using at least two transmitter/receiver pairs (with the transmitters and receivers being located on respective sides of the card) the invention can provide for at least double full duplex communications.

A process for fabricating the desired module is also described hereinafter. The process specifies the steps for fabricating the card itself, together with where and how to mount and assemble the various components of the module (the card, retainer means, optical receptacles, etc.) to achieve the objectives of the invention.

The invention features the aforementioned double sided card design (i.e., with transmitter(s) on one side and the receiver(s) on the other side of the card), and features the use of internal ground and power planes (located within the card itself) to maintain electrical isolation between the two sides of the card. The invention also features integration of the serializer with the laser driver to contribute to reducing the size of the card.

Further features of the invention, according to a preferred embodiment, include an electrical wrap capability for diagnostic purposes, the requirement of only a single +5 volt power supply, and surface edge mounting of the optical components and their leads.

These and other objects and features of the present invention, and the manner of obtaining them, will become apparent to those skilled in the art, and the invention itself will be best understood by reference to the following detailed description read in conjunction with the accompanying Drawing.

FIG. 1 depicts an exploded view of the optical link card communication module (both card and retainer) contemplated by the invention.

FIG. 2 depicts an enlarged view of an edge mounted optical assembly with leads brought in close to the plane of the circuit card in accordance with a preferred embodiment of the invention.

FIG. 3 depicts an enlarged view of a suitable standoff spacer for controlling card-to-card spacing for the modules fabricated in accordance with the teachings of the invention, together with a "J" clip extending from the spacer which operates as a flexible retention mechanism for affixing the novel modules to next level assemblies.

FIG. 4 is a functional block diagram of the invention, depicting the interconnection of various electrical and optical components on the card and how these components cooperate with one another.

FIG. 5 depicts an example of a power and ground plane structure for a double sided card that is fabricated in accordance with the teachings of the invention.

FIG. 6 depicts a preferred layout for the optical link card contemplated by the invention.

FIG. 1 depicts an exploded view of the optical link card communication module contemplated by the invention.

In particular, FIG. 1 depicts a double sided surface mount card, 101, that mounts to a user's system card. Data is transferred to and from the system card on n-bit wide parallel data busses.

For the sake of illustration only, the card depicted in FIG. 1 is designed to service 10 bit wide parallel data busses, i.e., n is set equal to 10. Those skilled in the art will readily appreciate that the components depicted in FIG. 1 could be modified to accommodate larger or smaller parallel busses.

The depicted card includes means for interfacing with the parallel data busses (connectors 102 and 103); means for interfacing with serial fiber optic transmission media (optical assemblies 104-107, further including receptacles 110 and 111 for lasers 120 and 121 respectively located within the receptacles; and receptacles 112 and 113 for photodetector diodes 122 and 123 respectively located within the receptacles); and a plurality of converters for performing conversion between both electrical and optical signals.

For the sake of illustration only, receptacles 110-113

are shown in FIG. 1 as an FC type optical fiber connector. Those skilled in the art will readily appreciate that the components depicted in FIG. 1 could include other types of fiber connectors.

These converters are described in detail hereinafter with reference to FIG. 4. However, with reference to FIG. 1, portions of two converters of a first type (for converting from electrical to optical signals) can be seen mounted on top of circuit card 101. In particular, serializer means 130 and 131, are modules which take parallel electrical data input (via connectors 102 and 103 respectively) for transmission, and convert the parallel electrical data to serial electrical data. Serializer means 130 and 131 then use the serialized data to drive lasers 120 and 121 respectively. According to one embodiment of the invention, serializer means 130 and 131 also each perform laser safety functions which will be described in detail hereinafter.

According to the preferred embodiment of the invention, the serializer and laser drive functions are integrated in serializer means 130 and 131 in order to help reduce the overall size of the novel card. The integrated functions of the serializer means will also be described in greater detail hereinafter with reference to FIG. 4.

Not shown in FIG. 1 (because they are mounted to the underside of card 101) are converters of a second type. These function to convert optical signals to electrical signals. The depicted illustrative card would have two such converters, each of which include means for amplifying the electrical signal generated by the photodetectors; means for detecting minimum DC light levels entering each of the photodetectors; and deserializer means for converting received serial data to parallel data. The deserializer further includes means for recovering the clock, means for generating a byte synchronization signal for output to the user, and means for detecting minimum AC light levels.

A detailed description of the deserializer components and how they cooperate will be set forth hereinafter with reference to FIG. 4 as well.

FIG. 1 goes on to show two open fiber control (OFC) means, 150 and 151. OFC means 150 turns off laser 120 if no light is received by the photodetector diode 122. OFC means 151 turns off laser 121 if no light is received by photodetector diode 123.

According to the preferred embodiment of the invention, OFC means 150 and 151 maintain a safe (class 1) optical power level in the event a fiber link is opened.

A suitable OFC module for use in conjunction with the invention is described in the European patent application EP-A-0 437 162 (inventors : G.M. Heiling, D.A. Knodel, M.J. Peterson ; and al), entitled "optical fiber link control safety system" and filed concurrently with the present invention.

Although the OFC module described in the reference is used in the preferred embodiment of the invention, other safety means (or indeed no safety means at all) may be used by those skilled in the art in place of the referenced OFC module without departing from the scope of the appended claims.

FIG. 1 also depicts laser drive adjustment potentiometers 170 and 171. These potentiometers may be used to adjust the AC and DC laser drive circuitry. The depicted potentiometers (170 and 171) are associated with laser 121 of FIG. 1. Not shown are corresponding potentiometers for each of the AC and DC drive portions of the laser drive circuitry associated with laser 120.

Also not shown (located on the underside of card 101) are metal shields for each of the aforementioned amplifiers. According to a preferred embodiment of the invention these shields serve to protect the amplifiers against stray electromagnetic fields.

In addition to the above described card, optical assemblies and electronics, FIG. 1 depicts retainer top 180 and retainer bottom 181, which include retainer retention clips (like clip 182), optical assembly slots (like slot 183), card alignment pins (like pin 184), card guide rail 185 and card hold down tabs (like tab 186), which when assembled in the manner indicated by FIG. 1 result in an embodiment of the optical fiber link card communication module contemplated by the invention.

According to the preferred embodiment of the invention, retainer top 180 and retainer bottom 181 are plastic and contribute to the ability of the novel module to provide good thermal isolation between the electronics and the lasers. This is an important feature of the invention since the electronics typically have a higher acceptable operating temperature then the lasers, which dissipate little power. In prior art hybrid type metal enclosed transmitters, the heat from the electronics can degrade the reliability and operation of the transmitters.

Furthermore, according to the preferred embodiment of the invention, the two piece retainer/holder described hereinabove (parts 180 and 181 as shown in FIG. 1) when assembled form a cradle to align and hold the optical assemblies at the edge of the card in an appropriate plane to permit surface attachment of the leads to the mating circuitry. As indicated hereinbefore, taking advantage of this feature minimizes lead capacitance and inductance.

FIG. 2 depicts an enlarged view of an edge mounted optical assembly with leads brought in close to the plane of the circuit card, as contemplated by the aforementioned preferred embodiment of the invention. In particular, FIG. 2 depicts leads 201-203 as being surface mounted (rather then using a pin-in-hole attachment) to card 101. Optical assembly 205 is shown mounted on the edge of card 101.

Referring again to FIG. 1, it can be seen that a "J" clip, clip 192, is depicted as a molded part of retainer bottom 181, extending from standoff spacer 193. The combination of clip 192 and spacer 193 may be used to attach, hold, align and space card/retainer assemblies to next level assemblies.

FIG. 3 depicts an enlarged view of a preferred arrangement for standoff spacer 193 (with the spacing

from the surface of card 101 to the next assembly being indicated by arrow 301), and "J" clip 192. Clip 192 is shown extending off of spacer 193. Operatively, clip 192 snaps into a mating hole in the main controller or interface card to which it plugs. As a molded plastic part, this clip has the flexibility to allow the nondestructive removal of the novel communication module when and if replacement is needed or desired.

Reference is now made to FIG. 4 which depicts a functional block diagram of the electrical and optical components on card 101.

In particular, FIG. 4 shows the combination of serializer means 430 and laser diode 431 which effectively converts parallel electrical signals to serial optical signals. The parallel signals are input from a parallel bus via, for example, an electrical connector such as connector 102 depicted in FIG. 1. The serial optical signals are output from laser 431 for transmission over fiber optic media, such as fiber 495 depicted in FIG. 4. Well known coupling lenses may be used within the laser receptacles depicted in FIG. 1 (such as receptacles 110 and 111) to direct the laser light into the fiber.

The details of how serializer 430 operates in conjunction with laser 431 will be set forth hereinafter with reference to the components (depicted in FIG. 4) shown to be included within serializer means 430. These details will be set forth in the context of an example wherein 10 bits of parallel electrical data are input to serializer 430, are converted to serial electrical format and output as serial optical data via laser 431 under the control of serializer 430.

FIG. 4 also depicts the combination of photodetector diode 425, DC detector 426, amplifier 427 and deserializer means 428, which effectively convert serial optical signals, received by photodetector 425, to parallel electrical signals. The parallel signals are driven by deserializer 428 onto a parallel electrical bus. An explanation of how serially received optical data signals are converted to parallel electrical data will also be set forth hereinafter with reference to the components depicted in FIG. 4.

Furthermore, FIG. 4 depicts OFC module 429, which, as indicated hereinbefore, preferably provides class 1 laser safety features on board the card itself. Reference is again made to the incorporated copending patent application which sets forth in detail how OFC module 429 operates in the context of the system depicted in FIG. 4.

To understand how the combination of serializer 430 and laser 431 operates, it is convenient to start at the point in FIG. 4 where the 10 bit parallel transmit data is input from a parallel electrical data bus to shift register 440. This takes place via depicted leads 470-479. As indicated hereinbefore these leads could, for example, correspond to user selected pins on an electrical connector, such as connector 102 depicted in FIG. 1.

The ten bit parallel transmit data entering shift register 440 is serially clocked out of shift register 440 under control of phase locked loop (PLL) 441. The PLL clock is phase locked to the lower frequency (off card) input transmit clock via link 405. The clock output on link 406 determines the serial transmit rate.

The serial data shifted out of shift register 440 is carried to AC drive 442 via link 407. AC drive 442 modulates laser 431 with the serialized data.

FIG. 4 also shows a DC drive, 443, contained in serializer 430. DC drive 443 keeps laser 431 at a preset power level. Additionally, DC drive 443, according to a preferred embodiment of the invention, contains safety circuits that can shut down laser 431 if an on card fault occurs that could produce an unsafe power level.

FIG. 4 depicts DC drive 443 as being coupled to laser 431 via link 408. Additionally, DC drive 443 is shown receiving an input from open fiber control (OFC) means 429 which, as will be explained hereinafter, can effectively force DC drive 443 (via link 409) to shut laser 431 off.

According to a preferred embodiment of the invention, DC drive 443 will issue a laser fault signal to the user via link 410, whenever a laser fault (e.g., an OFC ordered shut down) occurs.

Finally, with respect to DC drive 443, FIG. 4 shows (via dotted link 499) a feedback path from laser 431 to DC drive 443. A conventional automatic power control feedback circuit (not shown) senses light from the back facet of laser 431. According to the illustrative embodiment of the invention, optical output power is maintained at a constant level via DC drive 443 in response to the feedback signal. As indicated hereinbefore one of the adjustment potentiometers depicted in FIG. 1 indirectly controls DC drive 443. It is via the aforementioned feedback circuit that this control is effected.

Apparatus and techniques for performing the functions of the components shown included in serializer 430, namely shift register 440, PLL 441, AC drive 442 and DC drive 443, are well within the purview of those skilled in the art. Accordingly, these components do not require further explanation.

The above described serializer 430, comprising the combination of devices 440-443, effectively integrates the desired serializer and laser drive functions, in the manner, described, to help reduce overall card size. Furthermore, it can be seen with reference to the above description that serializer 430 functions as one of the plurality of electro-optical converters located on board the card. Control means for performing the conversion (e. g., PLL 441) are located on board the card as well.

The optical link card contemplated by the invention also includes on board circuitry for testing the card itself. In particular, FIG. 4 depicts multiplexer (MUX) 444 (for convenience shown as part of deserializer 428) which can be used to provide serialized data from serializer 430, to other deserializer 428 components, in a wrap mode. According to one embodiment of the invention, wrap mode can be user specified via link 411 which is shown coupled to MUX 444. A signal to enter wrap mode

causes the multiplexed data to be processed by deserializer 428.

The top portion of FIG. 4 depicts fiber 496 providing serial optical signals to photodetector diode 425. Fiber 496 may be "butt coupled" (held juxtaposed) to the active area of photodetector diode 425 to allow the transmitted light to be converted to electrical energy.

According to a preferred embodiment of the invention, the resultant current (from photodetector diode 425) is amplified by a transimpedence amplifier, 427, such as the NE-5210 amplifier depicted in FIG. 4.

PLL 445, shown included in deserializer 428, phase locks a serial receive clock to the data amplified by amplifier 427, and sends both the data and the clock to shift register 446 where the data is deserialized.

In a preferred embodiment of the invention, as depicted in FIG. 4, PLL 445 is shown locked to an on card crystal via link 412. The PLL is locked to the crystal to approximate the expected input data rate. The PLL then "fine tunes" the lock and locks onto the receive data at the actual receive data rate.

Shift register 446 includes a byte synchronization detector that is used to recognize a unique receive character so that complete bytes can be unloaded from shift register 446 without being fragmented. Shift register 446 also includes TTL drivers (which actually output the parallel data to a parallel data bus via leads 480-489) and means for outputting a byte synchronization signal to the user via link 413.

FIG. 4 also depicts clock generator 447 which, according to a preferred embodiment of the invention, is a four phase parallel receive clock. The four phase clock is useful for deriving non-overlap clocks which are typically used (or may be required) by the external system.

Clock generator 447 is shown tied to PLL 445 via link 414. Additionally, the four phase clock output from clock generator 447 is shown output on links 415-418 of FIG. 4.

Finally, deserializer 428 is shown to include transition detector 448. Transition detector 448, together with DC detector 426 (not included in the deserializer in the illustrative embodiment of the invention) detect minimum AC and DC light levels entering photodetector diode 425. These redundant signals are carried to OFC module 429 via links 460 and 461 and are used by OFC module 429 as a safety interlock to shut down the link if both fiber paths 495 and 496 are not hooked up.

The OFC module described in the referenced patent application, pulses laser 431 at a low duty cycle during the time the fiber link is open. This produces a safe optical power in the fiber. The referenced OFC module will return laser 431 to continuous power when the fiber link is reconnected.

OFC module 429 of FIG. 4 is shown to control laser 431 via link 409 to DC drive 443. Additionally, the preferred OFC module is shown to accept user inputs for turning the laser off and performing a power on reset function, via links 463 and 464 respectively. Link 465 is shown to provide a signal to the user when the fiber link is inactive. Finally, link 466 is shown to provide an indication to OFC module 429 whenever the user specifies wrap mode via link 411.

Apparatus and techniques for performing the functions of the components shown included in deserializer 428, namely PLL 445, shift register 446, clock generator 447, and transition detector 448, are well within the purview of those skilled in the art. The same holds true for laser 431, photodiode 425, amplifier 427, DC detector 426, and MUX 444, which are all commercially available devices. Accordingly, these components do not require further explanation.

What has been described with reference to FIG. 4 are the components, and how they interact, to form single full duplex operation. Card 101 of FIG. 1, constructed in accordance with a preferred embodiment of the invention, duplicates the components depicted in FIG. 4 to provide double full duplex operation.

According to the preferred embodiment of the invention, serializer 430, deserializer 428 and the TTL drivers in shift register 446 (even though part of deserializer 428), together with the duplicate set of these devices contemplated in FIG. 1, are connected to power (+5 volts) and ground planes within card 101. These planes and how the both sides (top and bottom) of card 101 are used in accordance with the teachings of the invention, are described hereinafter with reference to FIG. 5.

FIG. 5 illustrates that wiring land patterns 501 and 502 are respectively located on opposite surfaces (top and bottom) of card 101. These patterns are used to electrically interconnect the components mounted on each side of the card.

A side view of card 101, looking through the card into the surface labeled "A", shows that a card fabricated in accordance with the teachings of the invention contains a plurality of internal power and ground planes. By way of example these internal planes are depicted as planes 510-513 in FIG. 5. Planes 510 and 511 represent a ground and power plane, respectively, and service one side of the card (e.g., the components mounted on surface 501). Planes 512 and 513 represent another power and ground plane respectively, and service the other side of the card (e.g., the components mounted on surface 502).

Any combination of planes is possible. What is required according to the invention is that a plurality of internal power and ground planes be provided which inherently provide electrical isolation between the components mounted to the top and bottom surfaces of the card. Also, the components that perform the transmit function, and the components that perform the receive function, are to be located on opposite sides of the card.

According to the preferred embodiment of the invention, the internal power and ground planes that service the side of the card containing at least one deserializer, are partitioned so that the TTL drivers included in

shift register 446 (and any other shift register on this side of the card) are electrically isolated from the portion of the power and ground planes serving the remainder of a given deserializer. This is desirable because of the amount of current required for the TTL drivers.

Additionally, according to the preferred embodiment of the invention, the power and ground planes servicing the transmit function are fabricated so as not to cover (i.e., are fabricated to have an opening over) the aforementioned partitioned portion of the power and ground planes serving the TTL drivers. The purpose of fabricating the transmit function power and ground planes in this fashion is to keep noise from the TTL power and ground planes from coupling to the transmit power and ground planes.

Reference is now made to FIG. 6 which depicts a preferred layout for the optical link card contemplated by the invention. The layout shown provides double full duplex channels. The preferred card could be enlarged to provide further communication ports, or be cut in half (along line A-A of FIG. 6) to provide a single full duplex card.

The double full duplex channels depicted in FIG. 6 includes two identical but electrically isolated transmit/receive pairs comprised of laser 605 and photodetector diode 606 (one pair) and laser 607 and photodetector diode 608 (the other pair), mounted on a double sided surface mount card. There are no electrical connections, surface or internal, across the boundary formed by line A-A in FIG. 6.

As indicated hereinabove with reference to FIG. 5, the card has top and bottom signal planes and four internal power planes (not shown in FIG. 6) which may be used advantageously to isolate the transmitters from the receivers. For the sake of illustration, the top of the card depicted in FIG. 6 is labeled 601, while the bottom of the card is labeled 602.

To accommodate the 10 bit parallel buses serviced by the illustrative embodiment of the invention, two 48 pin connectors (connectors 102 and 103 in FIG. 1) with 100 mil pin centers are mounted on the top side of the card such that the pins protrude through the raw card to the bottom side where they would mate to the user's system card. This allows for minimal card to card spacing and a total card height that meets low profile requirements. The pin side of the connectors are illustrated in the layout depicted in FIG. 6 as connectors 650 and 651.

Four optical connectors, 609-612, are shown mounted juxtaposed to the lasers and photodetectors at the edge of the card. Connectors 609-612 easily protrude out into customer available access areas when the card is typically mounted onto a system card.

FIG. 6 also depicts the position of deserializer 680 and amplifier 681 (associated with photodetector diode 606) and deserializer 682 and amplifier 683 (associated with photodetector diode 608) as they are preferably mounted on the bottom surface, 602, of the card.

Serializer 630 and open fiber control module 631 (associated with laser 605). together with serializer 632 and open fiber control module 633 (associated with laser 607) are shown in the positions in which they are preferably mounted to the top side, 601, of the card.

The dimensions shown on FIG. 6 are for the purpose of illustration only, but indicate a suitable card size and suitable optical spacing to yield the desired, compact, double duplex communication module. The method for mounting the connector pins referred to hereinabove allows for 7 mm card to card spacing and a total card height of approximately 12 mm using the card depicted in FIG. 6.

What has been described are methods, apparatus and manufacturing techniques which meets all of the objectives set forth hereinbefore. Those skilled in the art will recognize that the foregoing description has been presented for the purposes of illustration and description only. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and obviously many modifications and variations are possible in light of the above teaching.

For example, components shown to be included in the deserializer, like MUX 444, could be located elsewhere, versions of the desired card could be produced without an electrical wrap capability or the on board safety features incorporated in preferred embodiments of the invention, etc.

The embodiments and examples set forth herein were presented in order to best explain the principles of the instant invention and its practical application to thereby enable others skilled in the art to best utilize the instant invention in various embodiments and with various modifications as are suited to the particular use contemplated.

Claims

1. An optical communication module, including a single multilayer double surface mount optical fiber link card (101) having a plurality of converters (130, 131) mounted thereon, for converting between parallel electrical signals and serial optical signals, wherein said optical signals are transmitted and received by the module over that at least one full duplex optical communication link (496, 495), comprising:

    first optical assembly means (105, 107), electrically coupled to at least one of said plurality of converters, including at least one axial leaded optical transmitter (205) that is optically coupled to said communication link; and being characterized in that it comprises:

    - retainer means (180,181), for holding said first optical assembly means (105, 107) in proximity to an edge of said card (101) so

as to align said at least one optical transmitter to said edge and facilitate attaching the leads of said at least one optical transmitter to the surface of said card.

2. The module as set forth in claim 1 wherein said module further comprises, second optical assembly means (104, 106), coupled to at least one of said plurality of converters, said means including at least one axial leaded optical receiver (205) for detecting serial optical signals input from said at least one full duplex optical communication link and for generating serial electrical signals in response thereto, wherein said retainer means (180, 181) is also operative to hold said second assembly (104, 106) in proximity to an edge of said card so as to align said at least one optical receiver to said edge and facilitate attaching the leads of said at least one optical receiver to the surface of said card.

3. The module as set forth in claim 1 or 2 wherein said retainer means is comprised of a two piece, snap together, retainer/holder (180, 181) which when assembled provides a slotted cradle for holding said first and second optical assembly means.

4. The module as set forth in claim 3 wherein said retainer means is molded from plastic and further comprises insert pins (184) and rails (185) to mechanically hold said first and second optical assemblies to said card.

5. The module as set forth in claim 4 wherein said retainer means further comprises flexible "J" clip (192) and stand off means (193).

6. The module as set forth in claim 4 wherein said retainer means thermally isolates said converter means from said optical transmitters.

7. An optical communication module according to any one of claims 1 to 6 characterized in that the at least one of said plurality of converters electrically coupled to the first optical assembly means are mounted on a first surface of the card and the at least one of said plurality of converters electrically coupled to the second optical assembly means are mounted on the second surface of the card.

8. An optical communication module according to any one of claims 1 to 7, wherein in that the converters (430) electrically coupled to the first optical assembly comprises:

(a) first phase locked loop means (441), locked to frequency of the parallel electrical signal input, for generating a serial transmit rate clock signals;

(b) first shift register means (440), coupled to said means for inputting parallel electrical signals and said first phase locked loop means, for converting input parallel electrical signals to serial electrical signals and outputting said serial electrical signals at said serial transmit rate;

(c) AC drive means (442), coupled to said first shift register means, for modulating said optical transmitters in response to said serial electrical signals; and

(d) DC drive means (443), coupled to said optical transmitters, for controlling the power level of said optical transmitter means.

9. The module as set forth in claim 8 wherein said DC drive means includes safety circuits which are capable of turning off power to said optical transmitters in the event of an on card fault.

10. The module as set forth in any one of claims 2 to 9, wherein the optical receivers are coupled to amplifier means, for amplifying the serial electrical signals generated by said optical receiver; and the converters (428) electrically coupled to the second optical means comprises:

(a) means (412) for generating serial transmit rate clock signals;

(b) second phase locked loop means (445), coupled to said amplifier means and said means for generating serial transmit rate clock signals, for locking said clock signals to data carried by said amplified serial electrical signal, and for serially outputting said data and clock signals; and

(c) deserializer means (446), coupled to said second phase locked loop means, for converting said amplified serial electrical signals to said corresponding parallel electrical signals, in response to the data and clock signals output by said second phase locked loop means.

11. The module as set forth in claim 10 wherein said deserializer means further comprises clock generator means (447) for generating and outputting a multiphase parallel rate transmit clock, and second shift register means (446), including TTL driver means, said second shift register means further comprising byte synchronization detector means which enable complete bytes to be unloaded from said second shift register means without fragmentation, and said second shift register means generating and outputting byte synchronization signals.

12. The module as set forth in anyone of claims 10 to 12 wherein the optical transmitter on the first optical assembly means is a laser and said card further comprises safety means (429) operative to ensure safe optical power levels in said at least one full duplex optical communication link in the event a given link is open, and wherein said safety means is further operative, to pulse said at least one laser at a low duty cycle when said given link is open and return said at least one laser to continuous power if said given link is reconnected.

13. The module as set forth in claim 12 wherein said card further comprises transition detector means (448) and DC detector means (426), coupled respectively to said amplifier means and said optical receivers, for respectively detecting minimum AC and DC light levels entering said optical receivers, wherein said safety means is coupled to said transition detector means and said DC detector means and operates in response to a failure by either of said detector means to detect said minimum AC and DC light levels, and wherein said safety means is also operative in response to off card generated safety means control sig nals, and further operative to output a signal indicative of at least one inactive link.

14. The module as set forth in any one of claims 7 to 10 wherein said card further comprises:

    (a) a first signal plane, located on a first surface of the card;

    (b) a second signal plane, located on a second surface of the card; and

    (c) a plurality of internal power and ground planes, which are connected to and electrically isolate said first signal plane from said second signal plane.

15. A process for manufacturing an optical communication module, including a single multilayer double surface mount optical fiber link card (101) having a plurality of converters (130, 131) mounted thereon, or converting between parallel electrical signals and serial optical signals, wherein said optical signals are transmitted and received by the module over at least one full duplex optical communication link (495, 496), comprising the steps of:

    (a) fabricating first optical assembly means (105, 107), electrically coupled to at least one of said plurality of converters, including at least one axial leaded optical transmitter (205) that is optically coupled to said communication link; and characterized in that said process further comprises the step of

    (b) fabricating retainer means (180, 181), for holding said first optical assembly (105, 107) in proximity to an edge of said card (101) so as to align said at least one optical transmitter to said edge and facilitate attaching the leads of said at least one optical transmitter to the surface of said card.

16. A process as set forth in claim 15 further comprising the step of fabricating second optical assembly means (104, 106), including at least one axial leaded optical receiver (205) for detecting serial optical signals input from said at least one full duplex optical communication link and for generating serial electrical signals in response thereto, wherein said retainer means (180, 181) fabricated in step (b) is also operative to hold said second assembly (104, 106) in proximity to an edge of said card so as to align said at least one optical receiver to said edge and facilitate attaching the leads of said at least one optical receiver to the surface of said card, the step of attaching the leads of said at least one optical transmitter and the leads of said at least one optical receiver, to the surface of said card, and wherein said step of fabricating retainer means further comprises the step of snapping together a two piece retainer/holder assembly that, when snapped together, provides a slotted cradle for holding said first and second optical assembly means, and wherein said step of fabricating retainer means further comprises the step of molding said retainer/holder assembly from plastic.

17. A process as set forth in claim 16 wherein said step of molding said retainer/holder assembly yields insert pins and rails to mechanically hold said first and second optical assemblies to said card, flexible "J" clip and stand off means which facilitate creating multicard assemblies, and means for thermally isolating said plurality of converters from said at least one optical transmitter.

Patentansprüche

1. Optisches Kommunikationsmodul mit einer einzelnen mehrlagigen, doppelseitig oberflächenmontierbaren (101) Karte für die Verbindung optischer Fasern, mit einer Vielzahl darauf montierten Konverter (130; 131), für die Umwandlung zwischen parallelen elektrischen Signalen und seriellen optischen Signalen, wobei die optischen Signale durch das Modul über wenigstens eine voll-duplex betriebene optische Kommunikationsverbindung (496, 495) gesendet und von ihm empfangen werden, wobei das Modul folgendes umfaßt:

erste optische Montagemittel (105, 107), die elektrisch mit wenigstens einem der vielen Konverter verbunden sind, wobei es wenigstens einen axial angeschlossenen optischen Sender (205) umfaßt, der elektrisch mit der Kommunikationsverbindung verbunden ist; und dadurch gekennzeichnet ist, daß es folgendes umfaßt:

- Spannmittel (180, 181), um die optischen Montagemittel (105, 107) in der Nähe einer Ecke der Karte (101) so zu halten, daß der wenigstens eine optische Sender zu der Ecke ausgerichtet wird und die Befestigung der Anschlüsse von dem wenigstens einen optischen Sender an die Oberfläche der Karte erleichtert wird.

2. Modul, wie es in Anspruch 1 beschrieben wird, wobei das Modul weiterhin folgendes umfaßt, zweite optische Montagemittel (104, 106), die mit wenigstens einem aus der Vielzahl Konverter verbunden sind, wobei das Mittel wenigstens einen axial angeschlossenen optischen Empfänger (205) zur Erkennung serieller optischer Eingangssignale von der wenigstens einen voll-duplex arbeitenden Kommunikationsverbindung und zur Erzeugung serieller elektrischer Signale als Antwort darauf enthält, wobei die Spannmittel (180, 181) ebenfalls wirksam sind, um den zweiten Aufbau (104, 106) in der Nähe einer Kante der Karte so zu halten, daß wenigstens der eine optische Empfänger zu der Kante ausgerichtet wird und die Befestigung der Anschlüsse von wenigstens dem einen optischen Empfänger auf der Oberfläche der Karte erleichtert wird.

3. Modul, wie es in Anspruch 1 oder 2 beschrieben wird, wobei die Spannmittel aus einem zweiteiligen, zusammenfügbaren Spanner/Halter (180, 181) bestehen, der, wenn er zusammengebaut wird, eine eingekerbte Halterung zum Halten der ersten und zweiten Montagemittel liefert.

4. Modul, wie es in Anspruch 3 beschrieben wird, wobei die Spannmittel aus Plastik geformt sind und weiterhin Haltestifte (184) und Rillen (185) zur mechanischen Halterung der ersten und zweiten optischen Aufbauten auf der Karte umfassen.

5. Modul, wie es in Anspruch 4 beschrieben wird, wobei die Spannmittel eine flexible "J"-Klemme (192) und Abstandsmittel (193) umfassen.

6. Modul, wie es in Anspruch 4 beschrieben wird, wobei die Spannmittel die Konvertiermittel thermisch von den optischen Sendern isolieren.

7. Optisches Kommunikationsmodul gemäß einem der Ansprüche 1 bis 6 dadurch gekennzeichnet, daß wenigstens einer aus der Vielzahl Konverter, die elektrisch mit den ersten optischer Montagemitteln verbunden sind, auf einer ersten Oberfläche der Karte montiert ist und daß wenigstens einer aus der Vielzahl Konverter, die elektrisch mit den zweiten optischen Montagemitteln verbunden sind, auf der zweiten Oberfläche der Karte montiert ist.

8. Optisches Kommunikationsmodul gemäß einem der Ansprüche 1 bis 7, bei dem der Konverter (430) elektrisch mit dem ersten optischen Aufbau verbunden ist, das folgendes umfaßt:

(a) erste Phasenregelkreis-Mittel (441), die mit der Frequenz des parallelen elektrischen Signaleingangs synchronisiert sind, zur Erzeugung von Taktsignalen mit der seriellen Übertragungsrate;

(b) erste Schieberegistermittel (440), die mit dem Mittel für die Eingabe paralleler elektrischer Signale und dem ersten phasengekoppelten Mittel verbunden sind, zur Konvertierung der Eingabe paralleler elektrischer Signale in serielle elektrische Signale und zur Ausgabe der seriellen elektrischen Signale mit der seriellen Übertragungsrate;

(c) Wechselstrom-Steuermittel (442), die mit dem ersten Schieberegistermittel verbunden sind, um die optischen Sender in Abhängigkeit von den seriellen elektrischen Signalen zu modulieren; und

(d) Gleichstrom-Steuermittel (443), die mit den optischen Sendern verbunden sind, um den Leistungspegel der optischen Sendemittel zu steuern.

9. Modul, wie es in Anspruch 8 beschrieben wird, wobei das Gleichstrom-Steuermittel Sicherheitsschaltungen enthält, die in der Lage sind, die Stromversorgung zu den optischen Sendern im Falle eines Kartenausfalls abzuschalten.

10. Modul, wie es in einem der Ansprüche 2 bis 9 beschrieben wird, wobei die optischen Empfänger mit Verstärkermitteln verbunden sind, um die von dem optischen Empfänger erzeugten seriellen elektrischen Signale zu verstärken; und wobei die Konverter (428), die elektrisch mit dem zweiten optischen Mittel verbunden sind, folgendes umfassen:

(a) Mittel (412) zur Erzeugung von Taktsignalen mit der serielle Übertragungsrate;

(b) zweite Phasenregelkreis-Mittel (445), die

mit dem Verstärkermittel und dem Mittel zur Erzeugung von Taktsignalen mit der seriellen Übertragungsrate verbunden sind, um die Taktsignale mit den Daten, die sich in dem verstärkten seriellen elektrischen Signal befinden, zu synchronisieren, und um die Daten und Taktsignale seriell auszugeben; und

(c) Entserialisierungsmittel (446), die mit den zweiten Phasenregelkreis-Mitteln verbunden sind, um die verstärkten seriellen elektrischen Signale als Reaktion auf die von dem zweiten Phasenregelkreis-Mittel ausgegebenen Daten- und Taktsignale in die zugehörigen parallelen elektrischen Signale umzuwandeln.

11. Modul, wie es in Anspruch 10 beschrieben wird, wobei das Entserialisierungsmittel weiterhin Taktgeneratormittel (447) für die Erzeugung und Ausgabe eines mehrphasigen parallelen Sendetaktes und ein zweites Schieberegistermittel (446) umfaßt, das TTL-Treibermittel enthält, wobei das zweite Schieberegistermittel weiterhin Nachweismittel für die Byte-Synchronisation enthält, die es ermöglichen, daß ein vollständiges Byte von dem zweiten Schieberegistermittel ohne Fragmentierung entladen werden kann und wobei das zweite Schieberegistermittel Byte-Synchronisationssignale erzeugt und ausgibt.

12. Modul, wie es in einem der Ansprüche 10 bis 12 beschrieben wird, wobei der optische Sender auf den ersten optischen Montagemitteln ein Laser ist und die Karte weiterhin Sicherheitsmittel (429) umfaßt, die betrieben werden, um in dem Falle, daß eine gegebene Verbindung offen ist, in der wenigstens einen voll-duplex arbeitenden optischen Kommunikationsverbindung sichere optische Leistungswerte sicherzustellen, wobei die Sicherheitsmittel weiterhin betrieben werden, um den einen Laser mit einer niedrigen Taktrate zu pulsen, wenn die gegebene Verbindung offen ist und um zur kontinuierlichen Leistung zurückzukehren, wenn die gegebene Verbindung wieder geschaltet ist.

13. Modul, wie es in Anspruch 12 beschrieben wird, wobei die Karte weiterhin Mittel für die Erkennung des Überganges (448) und Mittel für die Gleichstromerkennung (426) umfaßt, die mit den Verstärkermitteln beziehungsweise den optischen Empfängern verbunden sind, um minimale Gleichstrom- beziehungsweise Wechselstrom-Lichtpegel zu erkennen, die an den optischen Empfängern eingehen, wobei das Sicherheitsmittel mit dem Mittel zur Erkennung des Überganges und dem Mittel für die Gleichstromerkennung verbunden ist und als Reaktion auf einen Ausfall von einem der Nachweismittel zur Erkennung der minimalen Wechselstrom- und Gleichstrom-Lichtpegel arbeitet und wobei die Sicherheitsmittel ebenfalls als Reaktion auf die außerhalb der Karte erzeugten Steuersignale für die Sicherheitsmittel betrieben werden und ebenfalls auf die Ausgabe eines Signals reagieren, das wenigstens eine nichtaktive Verbindung anzeigt.

14. Modul, wie es in einem der Ansprüche 7 bis 10 beschrieben wird, wobei die Karte weiterhin folgendes umfaßt:

(a) eine erste Signalebene, die sich auf einer ersten Oberfläche der Karte befindet;

(b) eine zweite Signalebene, die sich auf einer zweiten Oberfläche der Karte befindet; und

(c) einer Vielzahl innerer Leistungs- und Masseebenen, die damit verbunden sind.und die die erste Signalebene von der zweiten Signalebene isolieren.

15. Verfahren zur Herstellung eines optischen Kommunikationsmoduls, das eine einzelne mehrlagige, doppelseitig oberflächenmontierbare Karte (101), für die Verbindung optischer Fasern mit einer Vielzahl darauf montierten Konverter (130, 131) für die Umwandlung zwischen parallelen elektrischen Signalen und seriellen optischen Signalen umfaßt, wobei die optischen Signale durch das Modul über wenigstens eine voll-duplex betriebene optische Kommunikationsverbindung (496, 495) gesendet und von ihm empfangen werden, wobei das Verfahren folgende Schritte umfaßt:

(a) Herstellung erster optischer Montagemittel (105, 107), die elektrisch mit wenigstens einem aus der Vielzahl von Konvertern verbunden sind, wobei diese wenigstens einen axial befestigten optischen Sender (205) enthalten, der optisch mit der Kommunikationsverbindung verhunden ist; und
das dadurch gekennzeichnet ist, daß das Verfahren weiterhin den folgenden Schritt umfaßt:

(b) Herstellung von Spannmitteln (180, 181) für die Halterung des ersten optischen Aufbaus (105, 107) in der Nähe einer Kante der Karte (101), so daß der wenigstens eine optische Sender zu der Kante ausgerichtet wird und die Befestigung der Anschlüsse von dem wenigstens einen optischen Sender auf der Oberfläche der Karte erleichtert wird.

16. Verfahren, wie es in Anspruch 15 beschrieben wird, bestehend aus dem Schritt zur Herstellung zweiter optischer Montagemittel (104, 106), die wenigstens einen axial befestigten optischen Empfänger (205)

für die Erkennung serieller optischer Signaleingaben an der wenigstens einen voll-duplex arbeitenden Kommunikationsverbindung und Erzeugung serieller elektrischer Signale als Reaktion darauf enthalten, wobei die Spannmittel (180, 181), die in Schritt (b) hergestellt werden, ebenfalls so betrieben werden, daß es den zweiten Aufbau (104, 106) in der Nähe einer Kante der Karte hält, um den wenigstens einen optischen Empfänger zu der Kante auszurichten und um die Befestigung der Anschlüsse von dem wenigstens einen optischen Empfänger auf der Oberfläche der Karte zu erleichetern, dem Schritt zur Befestigung der Anschlüsse des wenigstens einen optischen Senders und der Anschlüsse des wenigstens einen optischen Empfängers auf der Oberfläche der Karte, und wobei der Schritt zur Herstellung der Spannmittels weiterhin den Schritt des Zusammenfügens eines zweiteiligen Spanner/Halter-Aufbaus umfaßt, der, wenn er zusammengefügt wird, eine eingekerbte Halterung für das Halten der ersten und zweiten optischen Montagemittel liefert und wobei der Schritt zur Herstellung der Spannmittel weiterhin den Schritt zur Formung des Spanner-/Halter-Aufbaus aus Plastik umfaßt.

17. Verfahren, wie es in Anspruch 16 beschrieben wird, wobei der Schritt zur Formung des Spanner-/Halter-Aufbaus das Einfügen von Haltestiften und Rillen zur mechanischen Halterung der ersten und zweiten optischen Aufbauten auf der Karte, eine flexible "J"-Klemme und Abstandsmittel, die die Herstellung von Aufbauten mit mehreren Karten erleichtern, und Mittel für die thermische Isolierung der Vielzahl Konverter von dem wenigstens einen optischen Sender ermöglichen.

Revendications

1. Module de communication optique, comprenant une seule carte (101) de liaison à fibre optique à double montage en surface multicouche comportant une pluralité de convertisseurs (130, 131) montés sur celle-ci, destiné à effectuer une conversion entre des signaux électriques parallèles et des signaux optiques série, dans lequel lesdits signaux optiques sont émis et reçus par le module sur cette au moins une liaison de communication optique en duplex (496, 495), comprenant :

   un premier moyen de montage optique (105, 107), couplé électriquement à au moins l'un parmi ladite pluralité de convertisseurs, comprenant au moins un émetteur (205) optique à sortie axiale qui est couplé optiquement à ladite liaison de communication, et étant caractérisé en ce qu'il comprend :

   - un moyen de retenue (180, 181), destiné à maintenir ledit premier moyen de montage optique (105, 107) à proximité d'un bord de ladite carte (101) de façon à aligner ledit au moins un émetteur optique avec ledit bord et à faciliter la fixation des conducteurs dudit au moins un émetteur optique à la surface de ladite carte.

2. Module selon la revendication 1 dans lequel ledit module comprend en outre, un second moyen de montage optique (104, 106), couplé à au moins l'un parmi ladite pluralité de convertisseurs, ledit moyen comprenant au moins un récepteur optique à sortie axiale (205) destiné à détecter des signaux optiques série entrés à partir de ladite au moins une liaison de communication optique en duplex et destiné à engendrer des signaux électriques série en réponse à ceux-ci, dans lequel ledit moyen de retenue (180, 181) agit également pour maintenir le second montage (104, 106) à proximité d'un bord de ladite carte de façon à aligner ledit au moins un récepteur optique avec ledit bord et à faciliter la fixation des conducteurs dudit au moins un récepteur optique à la surface de ladite carte.

3. Module selon la revendication 1 ou la revendication 2, dans lequel ledit moyen de retenue est constitué d'un dispositif de retenue/maintien (180, 181) à deux pièces encliquetées ensemble, qui, lorsqu'il est assemblé, procure une entretoise à fentes afin de maintenir lesdits premier et second moyens de montage optique.

4. Module selon la revendication 3 dans lequel ledit moyen de retenue est moulé à partir de plastique et comprend en outre des broches d'insertion (184) et des barreaux (185) afin de maintenir mécaniquement lesdits premier et second montages optiques sur ladite carte.

5. Module selon la revendication 4 dans lequel ledit moyen de retenue comprend en outre une attache en "J" flexible (192) et un moyen de séparation (193).

6. Module selon la revendication 4 dans lequel ledit moyen de retenue isole thermiquement ledit moyen de convertisseur desdits émetteurs optiques.

7. Module de communication optique selon l'une quelconque des revendications 1 à 6 caractérisé en ce que le au moins un parmi ladite pluralité de convertisseurs couplé électriquement au premier moyen de montage optique est monté sur une première surface de la carte et que le au moins un parmi ladite pluralité de convertisseurs couplés électriquement au second moyen de montage optique est

monté sur la seconde surface de la carte.

8. Module de communication optique selon l'une quelconque des revendications 1 à 7, dans lequel les convertisseurs (430) couplés électriquement au premier montage optique comprennent :

(a) un premier moyen de boucle à verrouillage de phase (441), verrouillé sur la fréquence d'entrée du signal électrique parallèle, afin d'engendrer des signaux d'horloge de cadencement d'émission série,

(b) un premier moyen de registre à décalage (440), couplé audit moyen destiné à entrer des signaux électriques parallèles et audit moyen de boucle à verrouillage de phase, afin de convertir des signaux électriques parallèles en entrée en signaux électriques série et de sortir lesdits signaux électriques série suivant ledit cadencement d'émission série,

(c) un moyen d'attaque en courant alternatif (442), couplé audit premier moyen de registre à décalage, afin de moduler lesdits émetteurs optiques en réponse auxdits signaux électriques série, et

(d) un moyen d'attaque en courant continu (443), couplé auxdits émetteurs optiques, afin de commander le niveau de puissance dudit moyen d'émetteur optique.

9. Module selon la revendication 8 dans lequel ledit moyen d'attaque en courant continu comprend des circuits de sécurité qui sont capables de couper l'alimentation desdits émetteurs optiques dans le cas d'un défaut sur la carte.

10. Module selon l'une quelconque des revendications 2 à 9, dans lequel les récepteurs optiques sont couplés à un moyen d'amplificateur, destiné à amplifier les signaux électriques série engendrés par ledit récepteur optique, et les convertisseurs (428) couplés électriquement au second moyen optique comprennent :

(a) un moyen (412) destiné à engendrer des signaux de cadencement d'émission série,

(b) un second moyen de boucle à verrouillage de phase (445), couplé audit moyen d'amplificateur et audit moyen destiné à engendrer des signaux d'horloge de cadencement d'émission série, afin de verrouiller lesdits signaux d'horloge sur les données transportées pour ledit signal électrique série amplifié, et afin de sortir en série lesdites données et lesdits signaux d'horloge, et

(c) un moyen de convertisseur série parallèle (446), couplé audit second moyen de boucle à verrouillage de phase, afin de convertir lesdits signaux électriques série amplifiés en lesdits signaux électriques parallèles correspondants, en réponse aux signaux de données et d'horloge sortis par ledit second moyen de boucle à verrouillage de phase.

11. Module selon la revendication 10 dans lequel ledit moyen de convertisseur série parallèle comprend en outre un moyen de générateur d'horloge (447) destiné à engendrer et à sortir une horloge de cadencement d'émission parallèle multiphase, et un second moyen de registre à décalage (446), comprenant un moyen d'attaque à logique transistor-transistor, ledit second moyen de registre à décalage comprenant en outre un moyen de détecteur de synchronisation d'octets qui permet que des octets entiers soient déchargés depuis ledit second moyen de registre à décalage sans fragmentation, et ledit second moyen de registre à décalage engendrant et sortant des signaux de synchronisation d'octet.

12. Module selon l'une quelconque des revendications 10 à 12 dans lequel l'émetteur optique sur le premier moyen de montage optique est un laser et ladite carte comprend en outre un moyen de sécurité (429) agissant pour assurer des niveaux de puissance optique sûrs dans ladite au moins une liaison de communication optique en duplex dans le cas où une liaison donnée est rompue, et dans lequel ledit moyen de sécurité agit en outre, pour pulser ledit au moins un laser suivant un rapport cyclique faible lorsque ladite liaison donnée est rompue et fait revenir ledit au moins un laser à une puissance continue si ladite liaison donnée est reconnectée.

13. Module selon la revendication 12 dans lequel ladite carte comprend en outre un moyen de détecteur de transition (448) et un moyen de détecteur de courant continu (426), couplés respectivement audit moyen d'amplificateur et auxdits récepteurs optiques, afin de détecter respectivement des niveaux minimum de lumière en courant alternatif et en courant continu entrant dans lesdits récepteurs optiques, dans lequel ledit moyen de sécurité est couplé audit moyen de détecteur de transition et audit moyen de détecteur de courant continu et fonctionne en réponse à un échec de l'un desdits moyens de détecteur pour détecter lesdits niveaux de lumière en courant alternatif et courant continu minimum, et dans lequel ledit moyen de sécurité agit également en réponse aux signaux de commande de moyen de sécurité engendrés à l'extérieur de la car-

te, et agit en outre pour sortir un signal indicatif d'au moins une liaison inactive.

14. Module selon l'une quelconque des revendications 7 à 10 dans lequel ladite carte comprend en outre :

(a) un premier plan de signal, situé sur une première surface de la carte,

(b) un second plan de signal, situé sur une seconde surface de la carte,

(c) une pluralité de plans d'alimentation internes et de masse, qui sont couplés à et isolent électriquement ledit premier plan de signal dudit second plan de signal.

15. Processus de fabrication d'un module de communication optique, comprenant une seule carte (101) de liaison à fibre optique à double montage en surface multicouche, présentant une pluralité de convertisseurs (130, 131 montés sur celle-ci, destinés à effectuer des conversions entre des signaux électriques parallèles et des signaux optiques série, dans lequel lesdits signaux optiques sont émis et reçus par le module sur au moins une liaison de communication optique en duplex (495, 496), comprenant les étapes consistant à :

(a) fabriquer un premier moyen de montage optique (105, 107), couplé électriquement à au moins l'un parmi ladite pluralité de convertisseurs, comprenant au moins un émetteur optique à sortie axiale (205), qui est couplé optiquement à ladite liaison de communication, et caractérisé en ce que ledit processus comprend en outre l'étape consistant à

(b) fabriquer un moyen de retenue (180, 181), destiné à maintenir ledit premier montage optique (105, 107) à proximité d'un bord de ladite carte (101) de façon à aligner ledit au moins un émetteur optique avec ledit bord et à faciliter la fixation des conducteurs dudit au moins un émetteur optique sur la surface de ladite carte.

16. Processus selon la revendication 15 comprenant en outre l'étape consistant à fabriquer un second moyen de montage optique (104, 106), comprenant au moins un récepteur (205) optique à sortie axiale destiné à détecter des signaux optiques série entrés à partir de ladite au moins une liaison de communication optique en duplex et à engendrer des signaux électriques série en réponse à ceux-ci, dans lequel ledit moyen de retenue (180, 181) fabriqué à l'étape (b) agit également pour maintenir ledit second montage (104, 106) à proximité d'un bord de ladite carte de façon à aligner ledit au moins un récepteur optique avec ledit bord et à faciliter la fixation des conducteurs dudit au moins un récepteur optique sur la surface de ladite carte, l'étape consistant à fixer les conducteurs dudit au moins un émetteur optique et les conducteurs dudit au moins un récepteur optique, à la surface de ladite carte, et dans lequel ladite étape consistant à fabriquer le moyen de retenue comprend en outre l'étape consistant à encliqueter ensemble un montage de retenue/maintien à deux pièces qui, lorsqu'elles sont encliquetées ensemble, procurent une entretoise à fentes destinée à maintenir lesdits premier et second moyens de montage optiques, et dans lequel ladite étape consistant à fabriquer le moyen de retenue comprend en outre l'étape consistant à mouler ledit montage de retenue/maintien à partir de plastique.

17. Procédé selon la revendication 16 dans lequel ladite étape consistant à mouler ledit montage de retenue/maintien produit des broches d'insertion et des barreaux afin de maintenir mécaniquement lesdits premier et second montages optiques sur ladite carte, des attaches en "J" souples et un moyen de séparation qui facilitent la création de montages multicarte, et un moyen pour isoler thermiquement ladite pluralité de convertisseurs dudit au moins un émetteur optique.

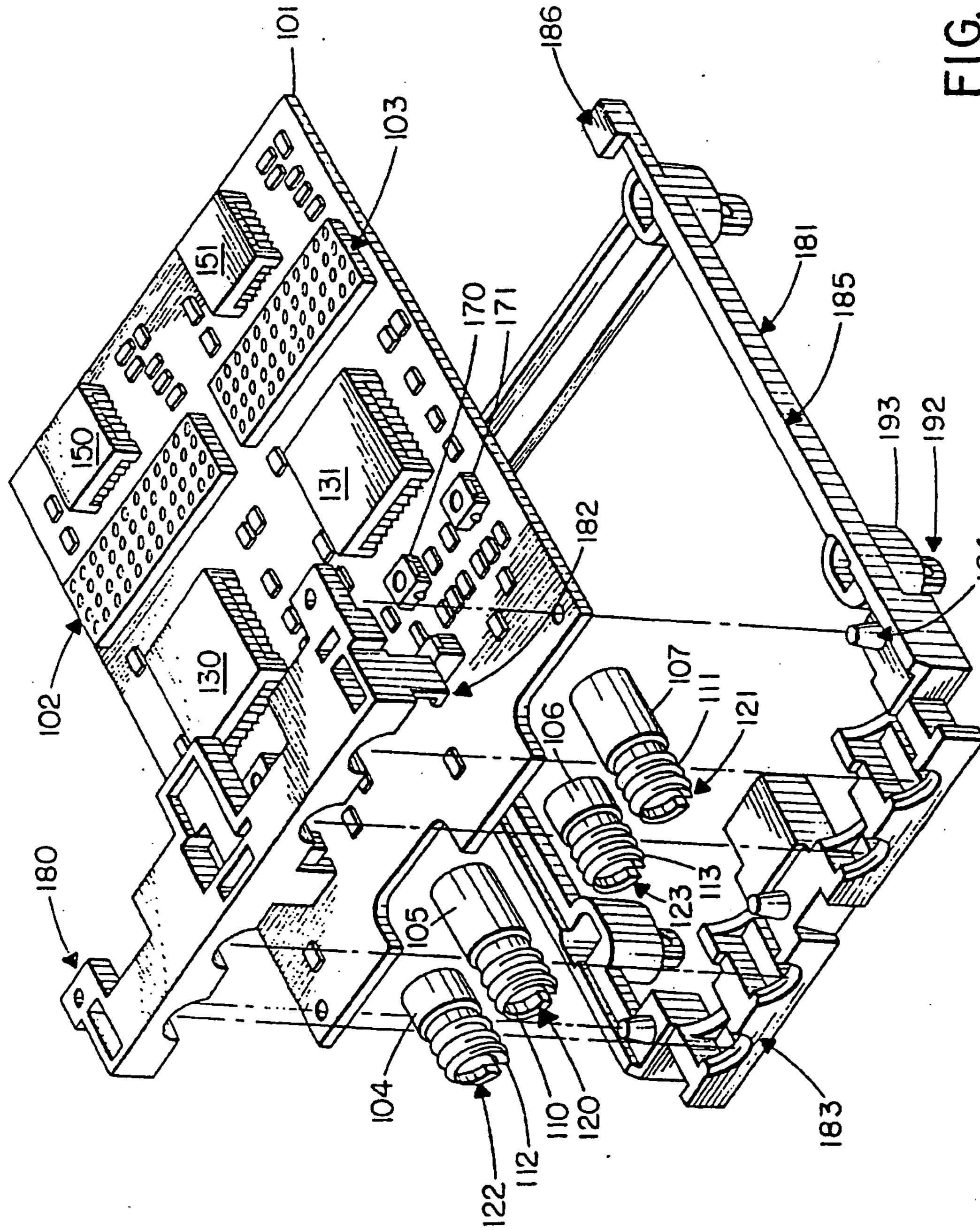
101
103
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FIG. 1.

FIG. 2.

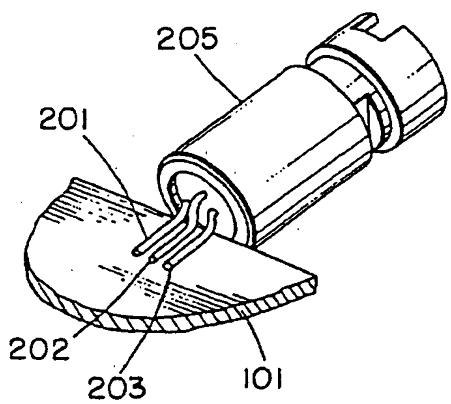


FIG. 3.

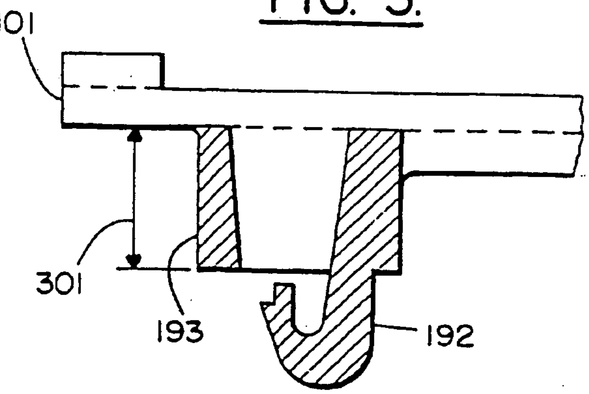
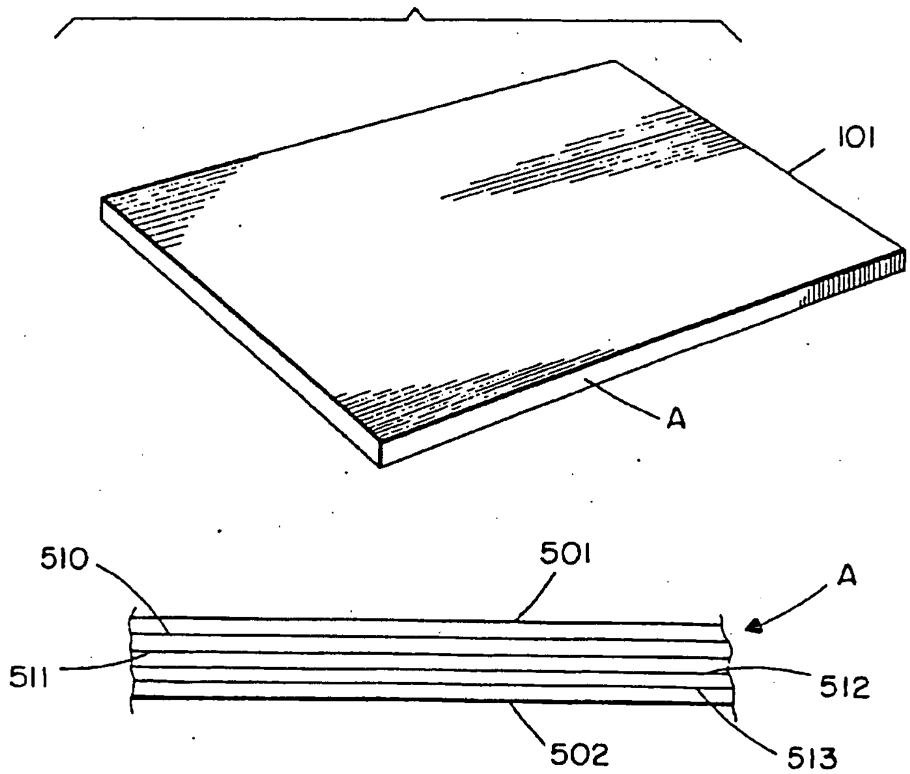


FIG. 5.



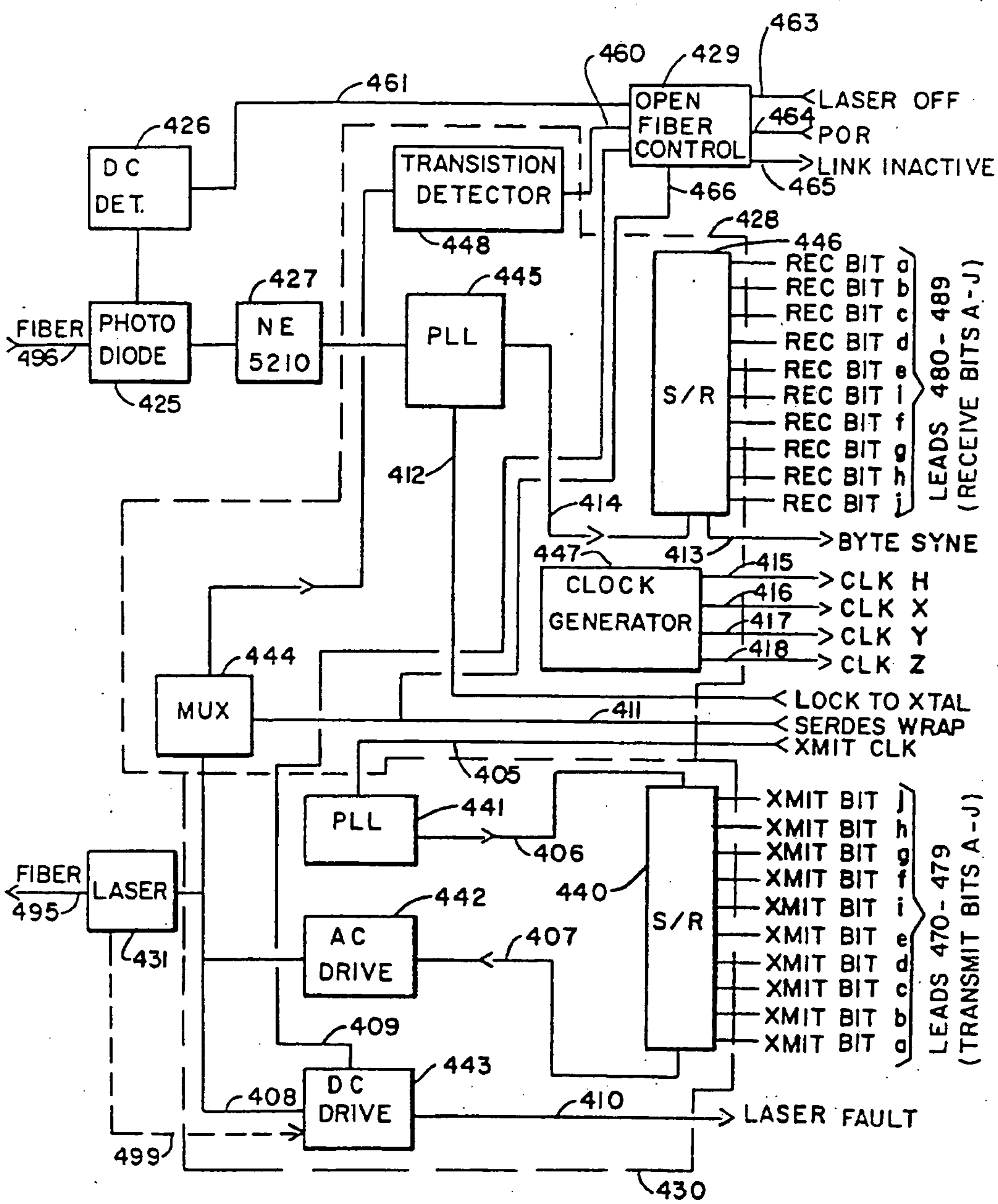
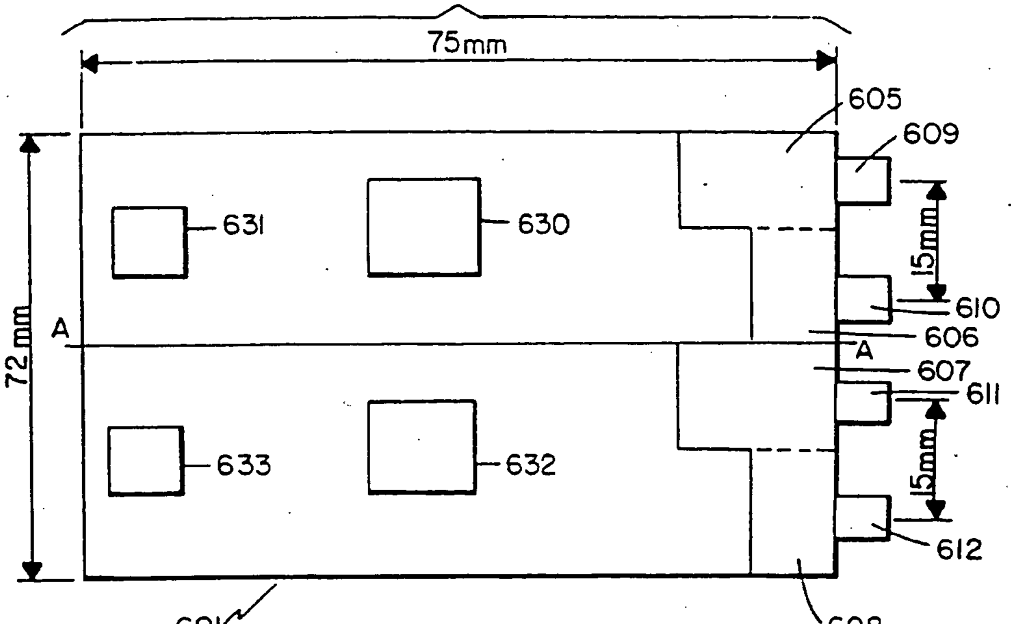

463
460
429
461
OPEN FIBER CONTROL
LASER OFF
464
POR
LINK INACTIVE
465
426
DC DET.
TRANSISTION DETECTOR
466
428
448
446
427
445
REC BIT a
REC BIT b
REC BIT c
REC BIT d
REC BIT e
REC BIT i
REC BIT f
REC BIT g
REC BIT h
REC BIT j
LEADS 480-489 (RECEIVE BITS A-J)
FIBER
496
PHOTO DIODE
NE 5210
PLL
S/R
425
412
414
BYTE SYNE
447
413
415
CLOCK GENERATOR
CLK H
416
CLK X
417
CLK Y
418
CLK Z
444
MUX
LOCK TO XTAL
411
SERDES WRAP
XMIT CLK
405
PLL
441
406
XMIT BIT j
XMIT BIT h
XMIT BIT g
XMIT BIT f
XMIT BIT i
XMIT BIT e
XMIT BIT d
XMIT BIT c
XMIT BIT b
XMIT BIT a
LEADS 470-479 (TRANSMIT BITS A-J)
FIBER
495
LASER
442
440
S/R
431
AC DRIVE
407
409
443
DC DRIVE
408
410
LASER FAULT
499
430

FIG. 4

FIG. 6



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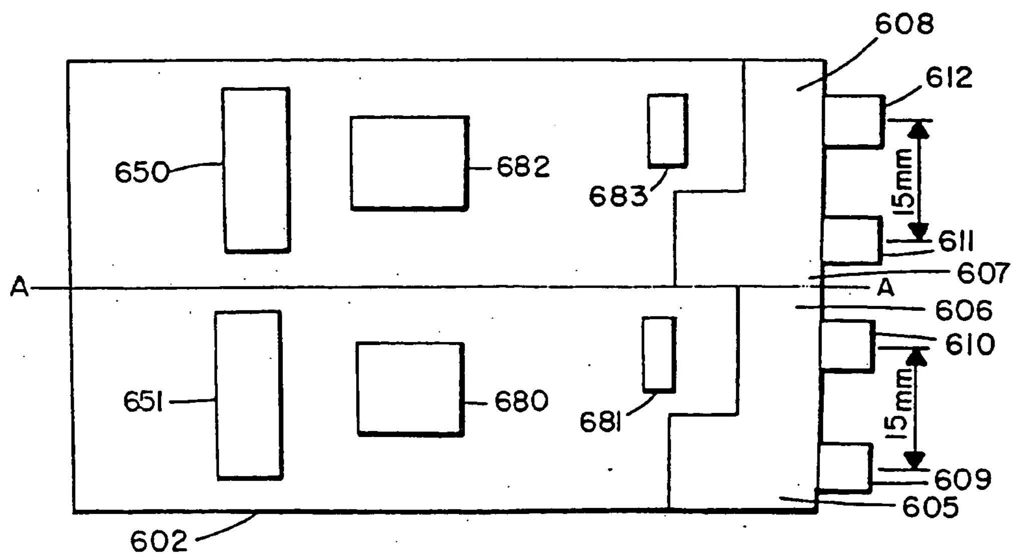

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